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Evaluation of different spacing on major pest and disease of tree type mulberry varieties V1 and G4

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Abstract
The experiments were carried out to incidence of pest and disease of two tree type Mulberry variety V1 and G4. The experimental study was done in Agriculture Research Station, Bhavanisagar, Tamil Nadu. The plants were planted in different spacing such as 5ft x 5ft, 6ft x 6ft and 7ft x 7ft with randomized block design. Continuous monitoring of major pest and disease in random sampling and incidence were recorded. The highest powdery mildew percent disease index (4.12%), Bacterial leaf spot (3.52%), root rot incidence (9.33%) and pest incidence such as leaf webber incidence (53.00%), Pink mealy bug incidence (54.50%) and thrips incidences (34.50%) in 5ft x 5ft spacing. Regarding the disease incidence, lowest powdery mildew percent disease index (2.75%), Bacterial leaf spot (2.17%), root rot incidence (7.55%) and pest incidence such as leaf webber incidence (19.34%), Pink mealy bug incidence (10.00%) and thrips incidences (9.50%) were recorded lowest incidence in the 6ft x 6ft spacing.

Keywords: Evaluation, spacing, major, mulberry, varieties

Introduction
Mulberry (*Morus* spp.) is a fast growing deciduous woody perennial plant, normally cultivated as dwarf tree or high bush by repeated pruning (Magadum *et al.,* 2019). During its cultivation, mulberry is vulnerable to the attack of several pests and diseases. This causes considerable damage to plant and reduce mulberry yield production in high level. Moreover, it lowers the quality of the leaf, making it unfit for feeding silkworms. Due to perennial nature of mulberry plants in combination with monoculture practices enhance the chances of infestation of several pests and disease all around the year. So far, almost 300 pest species, both insect and non-insect are attack mulberries (Rajadurai *et al.*, 2003) [18]. The major insect pests of mulberry are mealy bugs, leaf Webbers, thrips, cutworms and hairy caterpillars. Among various pest, pink mealy bug is a major pest which causes tukra disease in mulberry and estimated to 34.24% and 4500 kg/ha/year loss in mulberry. There are over 200 species of insects that are known to live in the mulberry ecosystem in India, and only a few of them have serious pest status (Muthulakshmi *et al.*, 2003) [15]. Approximately half of these are documented to appear throughout the year. These pests can be divided into two groups, sap suckers and leaf eaters/defoliators. Climate change's effects on the infestation of key pests in recent years, the Southern Sericultural States of India, namely Karnataka, Andhra Pradesh, and Tamil Nadu, have seen an increase in the threat posed by a new invader, leaf roller *D. pulverulentalis*, with an average incidence of 21.77% (Bhagyamma and Vijayakumari, 2022) [3].
Mealy bug, white fly, and thrips are among the most significant sap-sucking insect pests that severely infest mulberry bushes in West Bengal. The papaya mealy bug, *Paracoccus marginatus*, an invasive exotic pest, has entered West Bengal and was discovered infesting mulberries in 2013–2014 (Baidya and Chatterjee, 2020) [1]. Twenty diseases caused by fungi, bacteria, viruses, mycoplasma and nematodes have been reported so far in mulberry and causes upto 10% loss in quantity and upto 25% loss in quality. In all most all the sericultural countries, root rot is very serious threat to mulberry cultivation due to its epidemic nature and its potentiality to kill the plants completely (Gnanesh *et al.,* 2022) [7]. Powdery mildew caused by the ascomycete *Phyllactinia guttata* (syn. *P. corylea*) is a major foliar disease worldwide of the unique mulberry (Ramesha *et al.,* 2020) [20]. The study of mulberry pests and diseaae are great importance particularly for those areas where sericulture can be taken as an alternative source of income to enhance livelihood of people. For a healthy sericulture unit it is important to have healthy mulberry plants and for maintaining a healthy mulberry garden, it is important to gather information on its insect pests and disease.

Materials and Methods

Study on pest incidence of the tree type mulberry

Incidence of Thrips

The population of thrips (*Pseudodendrothrips mori*) is to be recorded from 10 randomly selected plants per replication per varieties. Selected the severely infested branch from each plant and count the number of thrips present on 4th to 6th leaves. Take the average of the four leaves and that shall be the mean thrips population per leaf. The economic threshold level of thrips population is 20/leaf.

Incidence of mealy bug

The mealy bug (Maconellicoccus hirsutus) causes the disease called tukra. To record the tukra infestation, 10 plants shall be selected randomly from each replication. Plant with the shoot tip affected by tukra is to be counted to estimate the percentage of infestation.

$$PI = \frac{\text{Number of shoots infected in the plant}}{\text{Number of shoots in the plant}} \times 100$$

Leaf webber incidence

The incidence of leaf webber (*Diaphania pulverulenatlis*) is to be recorded from randomly selected 10 plants and count the number of infected plants.

$$\text{Percentage of infestation} = \frac{\text{Total number of plants infested}}{\text{Total number of plants selected}} \times 100$$

Root rot

$$\text{Percent Disease incidence} = \frac{\text{Number of infected plants}}{\text{Total number of plants}} \times 100$$

Study on disease incidence of the tree type mulberry

Parameters involved are the Percentage Disease Index (PDI) of the major diseases *viz.*, bacterial leaf spot, powdery mildew and root rot. Data to be collected from five randomly selected plants from each variety and spacing in every replication. Counting of the number of leaf spots per leaf from the longest shoots of each plant and calculate the average number of spots per shoot from which finally the graded estimation of the diseases are to be made as follows

Bacterial leaf spot

Avg. No. of spots/leaf	Grade	Intensity
<4	1	Resistance
5-9	2	Resistance
14-19	3	Moderate
20-26	4	Susceptible
>27	5	Susceptible

Powdery mildew

Avg. No. of spots/leaf	Grade	Intensity
<10	1	Resistance
11-20	2	Resistance
21-30	3	Moderate
31-40	4	Susceptible
>41	5	Susceptible

The PDI to be calculated as follows

$$\text{PDI (Percentage Disease Index)} = \frac{\text{Sum of numeric Grades X 100}}{\text{Total number of plants x Maximum Grade}}$$

Results and Discussion

Effect of different spacing on pest incidence of the tree type mulberry

The pest incidences were recorded in every month of the year (Table 1). The highest leaf webber incidences were recorded in the month of October with 53.00% in 6ft x 6ft spacing followed by 51.50% of incidence in the month of November in 5ft x 5ft spacing. There is no incidence in the April to June. In regarding varieties, V1 was recorded highest incidence ranges from 19.34% to 22.12% in all the spacing compared to G4. In the interaction with varieties, spacing and different months, highest incidence in October with 57.00% in 5ft x 5ft spacing and least was observed in 2.00 percent in G4 variety of 6ft x 6ft spacing. Bhagyamma and Vijayakumari, (2016) [4] documented leaf webber incidence in November with very high of 94.5%. Since temperature gradually reduces from August to January and also favorable for the growth of plants the quality of the leaf is good and attracts various pests especially defoliators (Rahmathulla *et al*., 2012) [17]. This may be the reason for peak incidence in the months of November to January. The pest infestation was not found during the months of March, April, May, and June which are summer months. These observations are in conformity with the finding of Priyadharshini *et al*., (2018) who observed the peak incidence of *D. pulverulentalis* during October with 51.25 per cent infestation. Pink mealy bug incidences were observed in every months in each spacing (Table 2). The lowest incidence was observed in 6ft x 6ft spacing with 10.00% followed by 11.00% of 7ft x 7ft spacing. The highest incidences were recorded in 54.50% in 5ft x 5ft spacing. In order to varieties V1 was recorded highest in 31.61% followed by 29.92%. Manzoor *et al.*, (2020) documented that, severity of pink mealy bug incidence in the month of july to October with 24.13% in V1 varitey. In interaction effects, highest incidence were observed in 63.00% in July month of V1 variety with 5ft x 5ft spacing followed by 62.00% in June month of same spacing. Arpita and Moulita (2019) reported high peak population of july with 61.93% and least in March. The least pink mealy bug incidence was documented in G4 variety of 6ft x 6ft spacing with 8.00% incidence in the month of February. The study of Benchamin *et al.* (1997) provide a strong support to the current studies which reports highest damage or severity caused by Pink mealy bug ranges from 0.79 to 11.69% from July to August. During the winter seasons, average incidence of 22.15% was reported by Murugesh *et al.*, (2008) [14].

The thrips incidences were documented in every months (Table 3). The highest thrips incidences were recorded in the month of October with 34.50% in 5ft x 5ft spacing followed by 34.00% of incidence in the month of October in 7ft x 7ft spacing. Simliar results were coincidence with Ghosh *et al.*, (2000) [6], who reported maximum thrips incidence with 49.39% in the period of June to October. The lowest thrips

incidence were observed in 9.50% in 6ft x 6ft spacing. In regarding varieties, V1 was recorded highest incidence ranges from 15.61% to 20.38% in all the spacing compared to G4. In the interaction with varieties, spacing and different months, highest incidence in October with 38.00% in 5ft x 5ft spacing of G4 and least was observed in 7.00 percent in V1variety of 6ft x 6ft spacing. Muthuswami *et al*., 2010 [16] reported serious damage of thrips on mulberry upto 40.00%. The indicidence of thrips was maximum in December and February, while it was minimum in January and May (Manjunath and Shree, 2001) [12]. Lalitha *et al.*, (2017) [8] reported maximum incidence in the month of June to December of mulberry ecosystem.

Table 1: Observations on Leaf webber Incidence (%) of different spacing of tree type mulberry

Period		Leaf webber Incidence (%)								
		5ft x 5ft			6ft x 6ft			7ft x 7ft		
		V1	G4	Mean	V1	G4	Mean	V1	G4	Mean
Feb		21.00	17.00	19.00	18.00	13.00	15.50	19.00	14.00	16.50
March		5.00	4.00	4.50	3.00	2.00	2.50	4.00	4.00	4.00
April		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
June		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
July		13.00	7.00	10.00	11.00	6.00	8.50	13.00	8.00	10.50
August		23.00	16.00	19.50	20.00	13.00	16.50	23.00	14.00	18.50
September		45.00	30.00	37.50	41.00	25.00	33.00	45.00	27.00	36.00
October		57.00	45.00	51.00	50.00	43.00	46.50	53.00	46.00	49.50
November		55.00	48.00	51.50	49.00	45.00	47.00	51.00	46.00	48.50
December		35.00	37.00	36.00	32.00	32.00	32.00	36.00	33.00	34.50
January		35.00	32.00	33.50	33.00	27.00	30.00	37.00	28.00	32.50
February		26.4	23.90	25.15	21.00	19.00	20.00	24.00	22.00	23.00
Mean		24.26	19.99	22.12	21.38	17.30	19.34	23.46	18.61	21.03
CD (P=0.05)	T	1.08**			1.14**			1.99**		
	M	0.42**			0.45**			0.78**		
	T X M	1.52**			1.62**			2.81**		

*Significant, ** Highly Significant, NS – Non Significant; Each value is mean of six replications and pooled mean of two crops

Table 2: Observations on Pink mealybug incidence (%) of different spacing of tree type mulberry

Period		Pink mealybug incidence (%)								
		5ft x 5ft			6ft x 6ft			7ft x 7ft		
		V1	G4	Mean	V1	G4	Mean	V1	G4	Mean
Feb		14.00	11.00	12.50	12.00	8.00	10.00	13.00	9.00	11.00
March		14.00	11.00	12.50	12.00	8.00	10.00	13.00	9.00	11.00
April		23.00	17.00	20.00	21.00	14.00	17.50	23.00	15.00	19.00
May		60.00	37.00	48.50	55.00	31.00	43.00	57.00	33.00	53.00
June		62.00	24.00	43.00	54.00	21.00	37.50	57.00	24.00	40.50
July		63.00	23.00	43.00	60.00	20.00	40.00	61.00	21.00	41.00
August		22.00	33.00	27.50	18.00	29.00	23.50	19.00	31.00	25.00
September		45.00	43.00	44.00	40.00	38.00	39.00	43.00	39.00	41.00
October		56.00	53.00	54.50	48.00	46.00	47.00	49.00	47.00	48.00
November		13.00	38.00	25.50	12.00	33.00	22.50	13.00	36.00	24.50
December		12.00	23.00	17.50	10.00	20.00	15.00	12.00	21.00	16.50
January		15.00	17.00	16.00	13.00	14.00	13.50	15.00	16.00	15.50
February		12.00	18.00	15.00	10.00	17.00	13.50	14.00	18.00	16.00
Mean		31.61	26.76	29.19	28.07	23.00	25.53	29.92	24.53	27.23
CD (P=0.05)	T	1.59**			1.40**			1.79**		
	M	0.62**			0.55**			0.70**		
	T X M	2.25**			1.98**			2.54**		

*Significant, ** Highly Significant, NS – Non Significant; Each value is mean of six replications and pooled mean of two crops

Table 3: Observations on Thrips incidence (%) of different spacing of tree type mulberry

Period	Thrips incidence (%)								
	5ft x 5ft			6ft x 6ft			7ft x 7ft		
	V1	G4	Mean	V1	G4	Mean	V1	G4	Mean
Feb	17.00	27.00	22.00	15.00	25.00	20.00	17.00	26.00	21.50
March	13.00	14.00	13.50	11.00	13.00	12.00	13.00	15.00	14.00
April	8.00	14.00	11.00	7.00	12.00	9.50	8.00	14.00	11.00
May	15.00	10.00	12.50	13.00	9.00	11.00	16.00	10.00	13.00
June	18.00	9.00	13.50	15.00	5.00	10.00	15.00	7.00	11.00
July	21.00	16.00	18.50	17.00	13.00	15.00	19.00	16.00	17.50
August	28.00	16.00	22.00	24.00	13.00	18.50	27.00	18.00	22.50

September		23.00	31.00	27.00	21.00	30.00	25.50	24.00	34.00	29.00
October		31.00	38.00	34.50	26.00	32.00	29.00	27.00	34.00	30.50
November		20.00	23.00	21.50	18.00	21.00	19.50	19.00	25.00	22.00
December		17.00	11.00	14.00	14.00	8.00	11.00	17.00	9.00	13.00
January		16.00	43.00	29.50	12.00	36.00	24.00	15.00	39.00	27.00
February		12.00	13.00	12.50	10.00	12.00	11.00	14.00	16.00	15.00
Mean		18.38	20.38	19.38	15.61	17.61	16.61	17.76	20.23	19.00
CD (P=0.05)	T	1.31**			1.11**			1.16**		
	M	0.51**			0.43**			0.45**		
	T X M	1.85**			1.57**			1.64**		

*Significant, ** Highly Significant, NS – Non Significant; Each value is mean of six replications and pooled mean of two crops

Effect of different spacing on disease incidence of the tree type mulberry

The disease of tree type of mulberry various according with the spacing (Table.4). 6ft x 6ft spaced mulberry recorded the lowest powdery mildew percent disease index with 2.75% followed by 7ft x 7ft. Among the two mulberry varieties, V1 was found to be significantly highest of powdery mildew incidence with 3.68% and next with G4 (2.72%). In respect of interaction effect, there is no significant different among the varieties and spacing respect to powdery mildew incidence. Monir and Mandal (2016) [13] reported incidence of 10 to 15% of different varieties. Bacterial leaf spot were recorded highest incidence in the spacing of 5ft x 5ft with 3.12% incidence followed by 7ft x 7ft with 2.89% incidence. Regarding varieties, V1 (3.52%) was recorded highest leaf spot incidence than G4 (2.27%). Simlilarly Maji *et al*., 2006 reported the incidence of 7.28% in Italian mulberry. Comparison of the spacing and varieties, there is no interactions were observed. Maji *et al*., 2003 [10] reported the bacterial leaf spot incidence with 9.90% in mulberry. The mean disease severity index (PDI) of 82 mulberry germplasm across three years ranged from 0.04 to 24.11% (Banerjee *et al.*, 2009) [2]. The lowest root rot incidence were recorded in the spacing of 6ft x 6ft with 3.99% followed by 7ft x 7ft with 6.00%. V1 mulberry variety was recorded highest root rot incidence of 7.55% compared with G4 (4.44%). In the interaction effects of spacing and varieties, highest root rot incidence were recorded in the variety of V1 with 9.33% of 5ft x 5ft spacing followed by 7ft x 7 ft with 8.00% of same variety. The lowest incidence were recorded in variety G4 (2.66%) of 6ft x 6ft spacing. Rajeswari and Angappan (2018) [19] observed root rot in V1 variety with 55% of incidence in Thondamuthur of Coimbatore district. Mallikarujna *et al.*, (2010) [11] reported the root rot incidence of 2.01% in V1 variety of major growing of tree type mulberry areas of Karnataka.

Table 4: Observations on percent disease index (%) of different spacing of tree type mulberry

Treatments		powdery mildew			Bacterial Leaf spot			Root rot incidence		
		V1	G4	Mean	V1	G4	Mean	V1	G4	Mean
5ft x 5ft		4.12	3.06	3.59	3.76	2.66	3.12	9.33	6.66	7.99
6ft x 6ft		3.23	2.28	2.75	3.19	2.00	2.59	5.33	2.66	3.99
7ft x 7ft		3.69	2.83	3.26	3.62	2.17	2.89	8.00	4.00	6.00
Mean		3.68	2.72	3.20	3.52	2.27	2.87	7.55	4.44	5.99
CD (P=0.05)	T	1.04**			0.20**			0.42**		
	V	0.91**			0.11**			0.34**		
	T X V	NS			NS			0.59		

*Significant, ** Highly Significant, NS – Non Significant; Each value is mean of six replications and pooled mean of two crops

Conclusion

Mulberry leaves are the primary components of sericulture. So it is very important to know about the different pests and disease which can reduce the quality as well as the quantity of tree mulberry leaves which are directly feed to the silkworms. The present study concluded that major pest and disease incidences were reported lowest in the spacing of 6ft x 6ft followed by 7ft x 7ft. Regarding the varieties, V1 is prone to various pest and disease compared to variety G4. But comparing the yield parameters, V1 is highly suitable for the tree type cultivation. The incidence were documented in particular seasons and suitable control measures to manage the pest and disease were mostly adopted in both variety of tree type mulberry.

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